

WHAT IS CLAIMED IS:

1. A hydrostatic transaxle apparatus, comprising:
  - a housing filled therein with fluid so as to serve as a fluid sump;
  - an axle disposed in said housing;
  - a hydraulic pump disposed in said housing to be drivingly connected to a prime mover;
  - a hydraulic motor disposed in said housing to be drivingly connected to said axle; and
  - a center section disposed in said housing adjacently to said axle to fluidly connect said hydraulic pump and said hydraulic motor to each other, said center section including
    - a pump mounting surface onto which said hydraulic pump is mounted,
    - a motor mounting surface onto which said hydraulic motor is mounted, said motor mounting surface being parallel to said pump mounting surface, and
    - a common axis penetrating said center section through both said pump mounting surface and said motor mounting surface, wherein both rotary axes of said hydraulic pump and said hydraulic motor coincide with said common axis, and wherein said common axis is disposed substantially perpendicularly to a longitudinal direction of said axle.
2. The hydrostatic transaxle apparatus as set forth in claim 1, wherein said center section is separably secured in said housing.
3. The hydrostatic transaxle apparatus as set forth in claim 1, further comprising:
  - a pair of first and second housing members joined to each other through a joint surface along a longitudinal direction of said axle so as to constitute said housing, wherein said center section is separably secured with said first housing

member so as to set said joint surface between said pump mounting surface and said motor mounting surface in parallel, wherein said hydraulic pump mounted onto said pump mounting surface is disposed in said first housing member, and wherein said hydraulic motor mounted onto said motor mounting surface is disposed in said second housing member.

4. The hydrostatic transaxle apparatus as set forth in claim 1, further comprising:

a cooling fan disposed outside said housing so as to make an axis of said cooling fan coincide with said common axis, wherein most of said housing except a portion thereof for housing said axle is disposed within an area of rotary locus of said cooling fan when viewed along said common axis.

5. The hydrostatic transaxle apparatus as set forth in claim 1, further comprising:

a pump shaft, whose rotary axis serves as said rotary axis of said hydraulic pump, having a first end surface and a second end surface in parallel to each other;

a motor shaft, whose rotary axis serves as said rotary axis of said hydraulic motor, having a first end surface and a second end surface in parallel to each other;

a common hole, whose axis serves as said common axis, penetrating said center section through both said pump mounting surface and said motor mounting surface, wherein said pump shaft and said motor shaft are inserted together into said common hole so that said first end surfaces of said pump shaft and motor shaft face each other in said common hole.

6. The hydrostatic transaxle apparatus as set forth in claim 5, wherein said pump shaft and motor shaft are extended oppositely to each other from said respective first end surfaces thereof in said common hole to said respective second end surfaces thereof, wherein said axle is disposed between a pair of parallel surfaces in which said second end surfaces of both said pump shaft and motor shaft are disposed respectively.

7. The hydrostatic transaxle apparatus as set forth in claim 6, wherein said axle is disposed between a pair of parallel surfaces in which said first and second end surfaces of said motor shaft are disposed respectively.

8. The hydrostatic transaxle apparatus as set forth in claim 5, wherein said common hole of said center section is shaped so as to prevent said first end surfaces of both said hydraulic pump and motor from contacting with each other.

9. The hydrostatic transaxle apparatus as set forth in claim 5, wherein said motor shaft is integrally formed with a bevel gear so as to be drivingly connected to said axle.

10. The transaxle apparatus as set forth in claim 5, further comprising:  
a counter shaft disposed perpendicularly to said motor shaft so as to transmit torque of said motor shaft to said axle; and  
a face gear for drivingly connecting said counter shaft to said motor shaft.

11. The hydrostatic transaxle apparatus as set forth in claim 5, further comprising:

a movable pump swash plate disposed in said housing so as to change capacity and fluid-discharge direction of said hydraulic pump;

a control shaft supported by said housing so as to control said movable pump swash plate; and

a counter shaft disposed in said housing so as to transmit torque of said motor shaft to said axle, wherein said control shaft and said counter shaft are disposed in parallel to each other on a common surface.

12. The hydrostatic transaxle apparatus as set forth in claim 11, wherein said common axis is disposed on said common surface.

13. The hydrostatic transaxle apparatus as set forth in claim 1, wherein said center section is formed with a charge suction port for supplying fluid from said housing to a fluid circuit within said center section, further comprising:

a partition wall disposed in said housing so as to separate said charge suction port from said hydraulic pump and hydraulic motor mounted on said center section.

14. The hydrostatic transaxle apparatus as set forth in claim 13, wherein said partition wall is integrally formed of said housing.

15. The hydrostatic transaxle apparatus as set forth in claim 1, further comprising:

a pair of said axles; and

a differential unit disposed in said housing so as to differentially connect said pair of axles to each other, wherein said center section is disposed adjacently to said differential unit and one of said axles.

16. A hydrostatic transaxle apparatus, comprising:
- a pair of axles;
  - a differential unit differentially connecting said axles to each other;
  - an axial piston type hydraulic pump drivingly connected to a prime mover;
  - an axial piston type hydraulic motor drivingly connected to said differential unit;
  - a center section for fluidly connecting said hydraulic pump and hydraulic motor to each other, said center section having a pair of surfaces, wherein one of said surfaces serves as a pump mounting surface onto which said hydraulic pump is mounted and the other serves as a motor mounting surface onto which said hydraulic motor is mounted; and
  - a housing filled therein with fluid so as to serve as a fluid sump, said housing including
    - a pair of first housing portions for housing said respective axles,
    - a second housing portion disposed between said first housing portions so as to house said differential gear unit, and
    - a third housing portion interposed between one of said first housing portions and said second housing portion so as to house said hydraulic pump, said hydraulic motor and said center section, wherein said center section is disposed substantially at the center of said third housing portion and adjacently to said differential unit and one of said axles.
17. The hydrostatic transaxle apparatus as set forth in claim 16, wherein rotary axes of said hydraulic pump and hydraulic motor are disposed so as to coincide with a common axis penetrating said center section through both said pump mounting surface and motor mounting surface.

18. The hydrostatic transaxle apparatus as set forth in claim 17, further comprising:

a cooling fan disposed outside said housing so as to make an axis of said cooling fan coincide with said common axis, wherein said second and third housing portions of said housing are almost disposed within an area of rotary locus of said cooling fan when viewed along said common axis.

19. A hydrostatic transaxle apparatus, comprising:

a housing filled therein with fluid so as to serve as a fluid sump, said housing being formed by jointing a pair of separate housing members to each other;

an axle disposed in said housing;

a hydraulic pump disposed in said housing so as to be drivingly connected to a prime mover;

a hydraulic motor disposed in said housing so as to be drivingly connected to said axle;

a center section disposed in said housing so as to fluidly connect said hydraulic pump and hydraulic motor to each other;

a counter shaft disposed in said housing so as to transmit output force of said hydraulic motor to said axle; and

a support member being separate from said housing, said support member being fixed in said housing so as to rotatably support said counter shaft.

20. The hydrostatic transaxle apparatus as set forth in claim 19, further comprising:

a plurality of said support members; and

a motor swash plate of said hydraulic motor, wherein one of said support members is formed so as to retain said motor swash plate on an input side of said counter shaft.

21. The hydrostatic transaxle apparatus as set forth in claim 19, further comprising:

a brake provided on said counter shaft, wherein one side surface of said support member is used for controlling said brake.

22. A hydrostatic transaxle apparatus, comprising:

a housing filled therein with fluid so as to serve as a fluid sump, said housing being formed by jointing a pair of separate housing members to each other;

an axle disposed in said housing;

a hydraulic pump disposed in said housing so as to be drivingly connected to a prime mover;

a hydraulic motor disposed in said housing so as to be drivingly connected to said axle, wherein a rotary axis of said hydraulic motor is disposed perpendicularly to said axle;

a center section disposed in said housing so as to fluidly connect said hydraulic pump and hydraulic motor to each other;

a motor swash plate of said hydraulic motor disposed in said housing;  
and

a retainer disposed in said housing so as to retain said motor swash plate, wherein said retainer is separably secured with said housing.

23. The hydrostatic transaxle apparatus as set forth in claim 22, wherein said retainer is fixed to one of said separate housing members.

24. The hydrostatic transaxle apparatus as set forth in claim 22, wherein said retainer is fixed to said center section.

25. A hydrostatic transaxle apparatus, comprising:

a housing filled therein with fluid so as to serve as a fluid sump;

a horizontal axle disposed in said housing;

a hydraulic pump disposed in said housing so as to be drivingly connected to a prime mover;

a hydraulic motor disposed in said housing so as to be drivingly connected to said differential gear unit;

a center section disposed in said housing so as to fluidly connect said hydraulic pump and hydraulic motor to each other, wherein said hydraulic pump is disposed above said hydraulic motor through said center section;

a vertical pump shaft of said hydraulic pump, a top end surface of said pump shaft being disposed in a first horizontal surface; and

a vertical motor shaft of said hydraulic motor disposed coaxially with said pump shaft, a bottom end surface of said motor shaft being disposed in a second horizontal surface, wherein said axle is disposed between said first and second horizontal surfaces.

26. The hydrostatic transaxle apparatus as set forth in claim 25, wherein a top end surface of said motor shaft is disposed in a third horizontal surface, and wherein said axle is disposed between said second and third horizontal surfaces.

27. The hydrostatic transaxle apparatus as set forth in claim 25, said pump shaft projecting outward from said housing, further comprising:



a cooling fan provided on the outward projecting portion of said pump shaft, wherein most of said housing except a portion thereof for housing said axle is disposed within an area of rotary locus of said cooling fan when being viewed along said pump shaft.

28. The hydrostatic transaxle apparatus as set forth in claim 25, wherein said pump shaft and said motor shaft are disposed coaxially with each other so as to face each other within said center section, and wherein said center section is formed so as to prevent said motor shaft from being slipped upward from a proper position thereof.

29. The hydrostatic transaxle apparatus as set forth in claim 25, further comprising:

a movable pump swash plate disposed in said housing so as to change capacity and fluid-discharge direction of said hydraulic pump;

a control shaft supported by said housing so as to control said movable pump swash plate; and

a counter shaft disposed in said housing so as to transmit torque of said motor shaft to said axle, wherein said control shaft and said counter shaft are disposed in parallel to each other on a common vertical surface.

30. The hydrostatic transaxle apparatus as set forth in claim 29, wherein said coaxial axes of said pump and motor shafts are disposed on said common vertical surface.

31. The hydrostatic transaxle apparatus as set forth in claim 25, wherein said center section is formed with a charge suction port for supplying fluid from said housing to a fluid circuit within said center section, further comprising:

a partition wall disposed in said housing so as to separate said charge suction port from said hydraulic pump and hydraulic motor mounted on said center section.

32. The hydrostatic transaxle apparatus as set forth in claim 31, wherein said partition wall is integrally formed of said housing.

33. The hydrostatic transaxle apparatus as set forth in claim 25, wherein said vertical motor shaft is integrally formed with a bevel gear so as to be drivingly connected to said horizontal axle.

34. The transaxle apparatus as set forth in claim 25, further comprising:  
a counter shaft disposed in said housing so as to transmit torque of said motor shaft to said axle, said counter shaft being disposed perpendicularly to said motor shaft; and

a face gear for drivingly connecting said counter shaft to said motor shaft.

35. A hydrostatic transmission, comprising:  
a housing filled therein with fluid so as to serve as a fluid sump;  
a hydraulic pump disposed in said housing;  
a hydraulic motor disposed in said housing;  
a center section formed therein with a closed circuit fluidly connecting said hydraulic pump and said hydraulic motor to each other, said center section disposed in said housing

a valve device attached to said center section so as to bring said closed circuit into communication with said fluid sump in said housing, wherein said valve device can be switched between a charge mode for allowing only fluid

flowing from said fluid sump to said closed circuit and a drain mode for allowing free oil flowing between said fluid sump and said closed circuit.

36. The hydrostatic transmission as set forth in claim 35, wherein said valve device is reversed by rotation so as to be put into either said charge mode or said drain mode.

37. The hydrostatic transmission as set forth in claim 36, said valve device comprising:

a valve member, and

a valve seat, wherein, when said valve device is put in said charge mode, said valve seat is disposed below said valve member so that said valve seat and said valve member abut against each other and can be separated from each other by flow of fluid from said fluid sump, and

wherein, when said valve device is put in said drain mode, said valve seat is disposed above said valve member and constantly separated from said valve member.

38. The hydrostatic transmission as set forth in claim 36, wherein an outer end portion of said valve device is disposed outside said housing so that a tool for rotating said valve device can fit said outer end portion of said valve device.

39. The hydrostatic transmission as set forth in claim 38, further comprising:

a detent surface formed on said outer end portion of said valve device;

and

a spring member pressed against said outer end portion of said valve device, wherein said spring member is pressed against said detent surface

during the rotation of said valve device so as to locate said valve device into either said charge mode or said drain mode.

40. A hydrostatic transaxle apparatus, comprising:
- a housing filled therein with fluid so as to serve as a fluid sump;
  - an axle disposed in said housing;
  - a gear disposed centered on said axle in said housing;
  - a hydraulic pump disposed in said housing, said hydraulic pump having a pump shaft for receiving power from a prime mover; and
  - a hydraulic motor disposed in said housing to be fluidly connected to said hydraulic pump, said hydraulic motor having a motor shaft drivingly connected to said gear so as to transmit torque of said motor shaft to said axle through said gear,
- wherein a rotary axis of said pump shaft and a rotary axis of said motor shaft are disposed on one side of said axle and substantially perpendicular to a rotary axis of said axle, and
- wherein, when said axle being axially viewed, said rotary axis of said pump shaft and said rotary axis of said motor shaft are disposed nearer than an outer periphery of said gear.

41. A hydrostatic transaxle apparatus, comprising:
- a housing filled therein with fluid so as to serve as a fluid sump;
  - an axle disposed in said housing;
  - an intermediate shaft disposed in said housing in parallel to said axle;
  - a deceleration gear train disposed in said housing so as to drivingly connect said intermediate shaft to said axle;

a hydraulic pump disposed in said housing, said hydraulic pump having a pump shaft for receiving power from a prime mover, and said hydraulic pump having a control arm for adjusting capacity of said hydraulic pump; and

a hydraulic motor disposed in said housing to be fluidly connected to said hydraulic pump, said hydraulic motor having a motor shaft drivingly connected to said intermediate shaft,

wherein said pump shaft and said motor shaft are disposed above and below on one side of said axle and substantially perpendicular to said axle, and

wherein said control arm and said deceleration gear train are distributed between opposite sides of said axle with respect to said pump shaft in the longitudinal direction of said axle.